Inside INEEL

An inside look at the Idaho National Engineering and Environmental Laboratory

INEEL
Home of Science and Engineering Solutions

Summer 2004
Idaho Falls, Idaho

A facility managed and operated by Bechtel BWXT Idaho, LLC

Best Attributes of Both Labs

New Idaho National Laboratory to focus on nuclear energy, national security research

While the INEEL is busy doing outstanding research for the nation, the U.S. Department of Energy is planning an even better national laboratory – the Idaho National Laboratory. The new lab will be a combination of the best attributes of the INEEL and Argonne National Laboratory-West, and it will be focused on nuclear energy and national security research and development, while maintaining a strong emphasis on DOE's other two missions, science and environmental research.

DOE issued in May a final Request for Proposal for private companies to manage and operate the new INL. The RFP envisions the new laboratory being the center "of our efforts to expand the use of nuclear energy as a reliable, affordable and clean energy source for our nation's energy future, and establish opportunities for Idaho business, its people and universities," said Energy Secretary Spencer Abraham. DOE also plans to release the final RFP for a contract to accelerate cleanup of past contamination of the INEEL.

*See **Best Attributes**, page 3*

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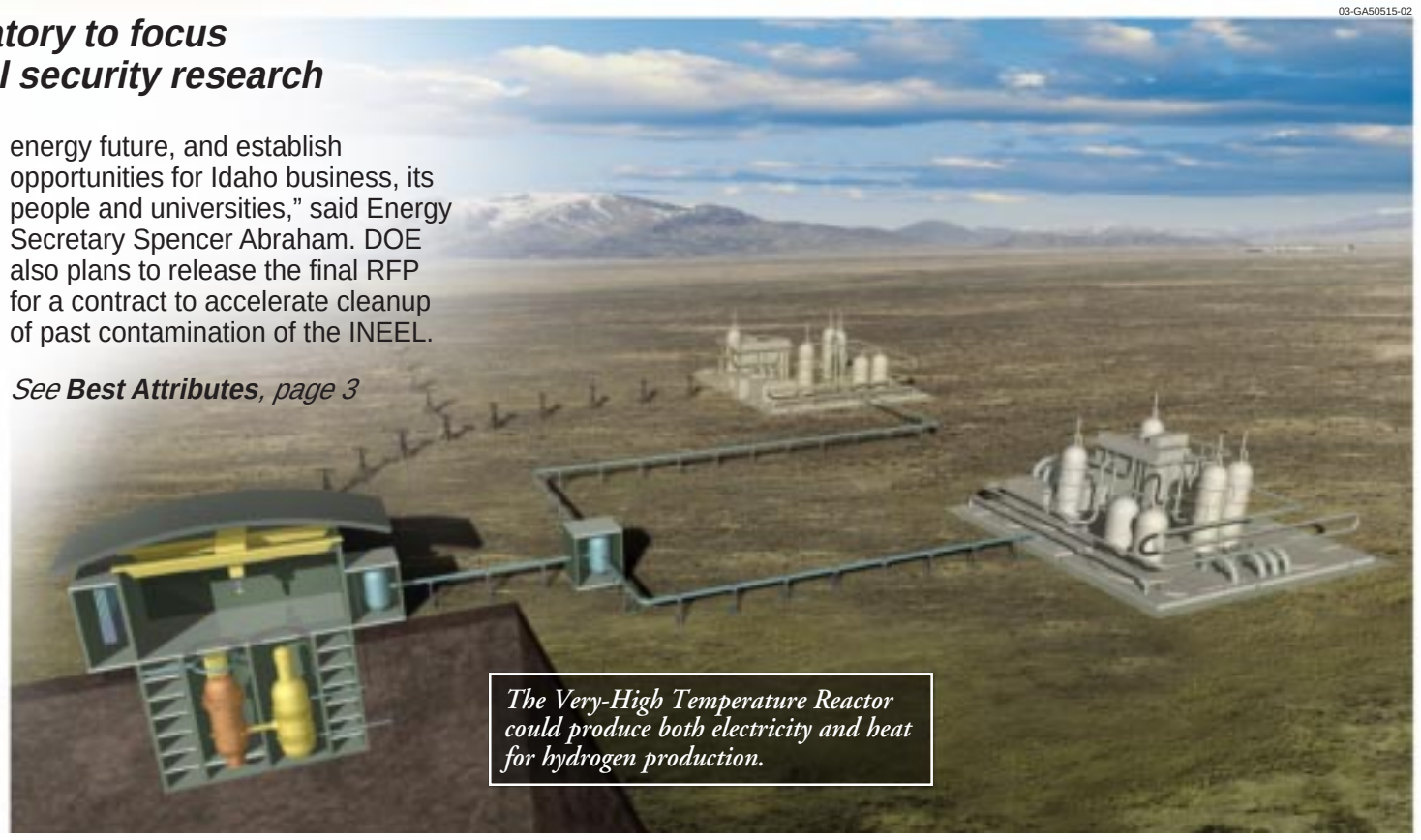

The Very-High Temperature Reactor could produce both electricity and heat for hydrogen production.

Protecting Our Nation's Energy Security

Most Americans expect to be able to fill up their tanks when they drive to a gas station. They expect to have warm homes and light to read by. They want their computers and trains to run, planes to take off on time and their coffee to be hot and fresh at the local drive-through.

All of this takes abundant, reliable energy, and that's where the Idaho National Engineering and Environmental Laboratory comes in. As part of its overall energy security mission, INEEL scientists and engineers are conducting a gamut of programs and projects from examining the viability and safety of the newest concepts for a new generation of nuclear reactors to developing efficient methods to harness the wind. The INEEL's National Security Division also focuses on energy security. In addition to developing alternative energy sources, the division's engineers and technicians work to protect the systems that exist today.

"One of our jobs is to reduce or eliminate vulnerabilities of critical infrastructure systems that operate today," said Ken Watts, director of National Security's Infrastructure and Defense Systems organization. "Whether they're threats from terrorism, impacts from natural disasters or just the effects from aging infrastructure, we look to identify vulnerabilities before the worst can happen, then find ways to fix them." Critical infrastructure includes those systems that are vital for the operation of the country, such as energy production and distribution, communications and transportation.

To fix the vulnerabilities, they must first be known. The Laboratory's security staff, for instance, is helping the Nuclear Regulatory Commission review the security plans for commercial reactors. If there are issues, these experts will identify them.

In addition to the INEEL's work in analyzing the theoretical, other experts appraise the actual. At the request of the federal departments of Energy and Homeland Security, the INEEL sends teams to critical infrastructure sites throughout the nation, such as ports and refineries, to find the weak links in security vulnerabilities and to suggest corrections.

*See **Energy Security**, page 2*

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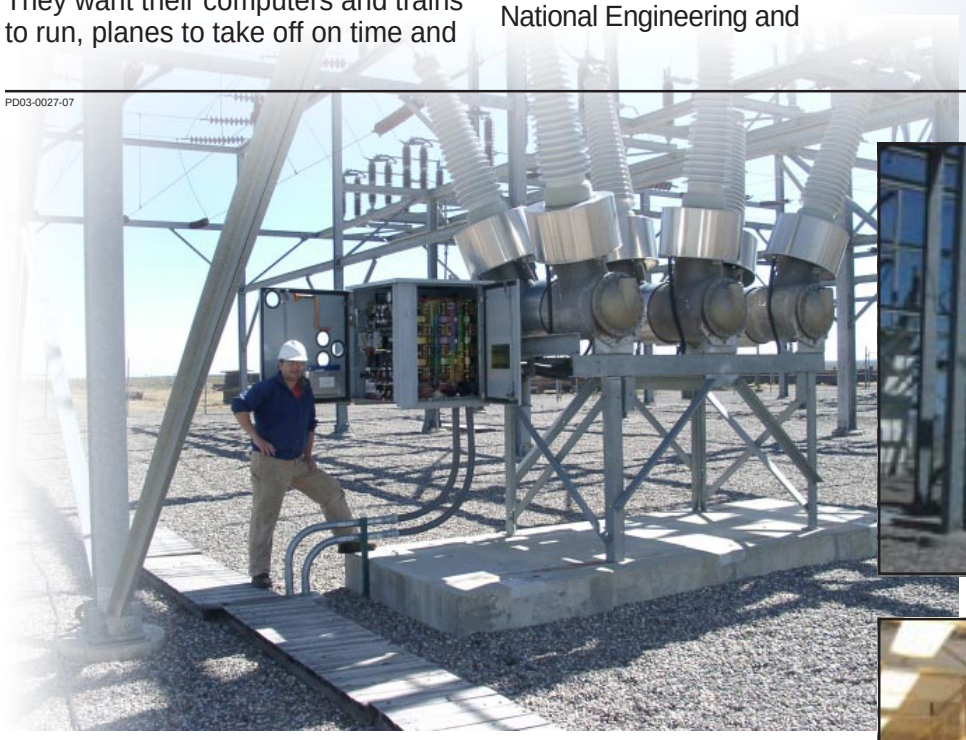

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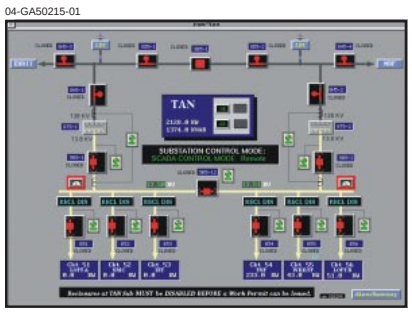

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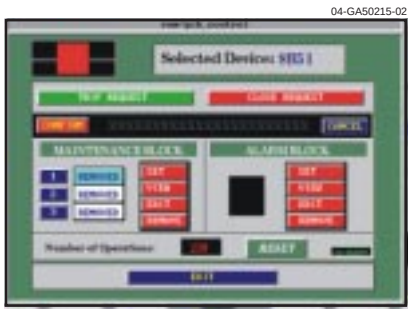

The INEEL is testing ways to reduce or eliminate vulnerabilities of critical infrastructure systems that are vital for the operation of the country, such as energy production and distribution, communications and transportation. The INEEL's power management systems (some of which are shown above) make the INEEL Site an ideal energy security test bed.

Published by the Idaho National Engineering and Environmental Laboratory

INEEL Inventors Take Center Stage

One hundred inventors were recognized for their inventions and the 39 patents they earned in 2003 at the eighth annual Inventors' Banquet hosted by the Department of Energy's INEEL.

The inventions are in technology areas including environmental protection and cleanup, energy, medical research and industrial welding.

Nine of the inventors were inducted into the INEEL's "Inventors Hall of Fame." Three of them were each presented with $10,000 lifetime achievement awards for generating 10 or more inventions, and six each received $2,500 for generating five or more inventions.

INEEL Laboratory Director Paul Kearns noted, "Our scientists, engineers and researchers produce some of the most remarkable advances in America. We are the only national laboratory to recognize our people with a tiered lifetime Hall of Fame achievement award for producing 5, 10, 15 and 20 inventions."


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To date, 25 INEEL inventors have amassed more than 150 inventions and, along with the scientific and engineering peer recognition, they have earned about $117,500 in special awards from licensing agreements that provide royalty income.

Among the contributions recognized at the banquet were a dozen patents for environmental technologies and more than half a dozen in energy technologies, research in selective cell destruction of AIDS virus, supercritical fluid coatings for fibers used in many products, and a new method of ultrasonic weld inspection that is accomplished as the weld is made. These and many other patents have exceptional potential for application in health, manufacturing, environmental cleanup, national security, nuclear and fossil-fuel energy systems, renewable energy systems and other areas. For details, visit the Web site at www.inel.gov/techtransfer/halloffame/.

(For more information, call Keith Arterburn, 208-526-4845)

Dennis Bingham, James Sisson and Joel Hubbell were recognized in the INEEL's Hall of Fame for producing 10 or more patented inventions during their careers.

International Nuclear Group Meets in Idaho, Tours INEEL and ANL-W

The eyes of the world's leading nuclear power-producing nations were on the INEEL and Argonne National Laboratory-West in early May, when representatives from 11 member organizations met to continue discussing Generation IV International Forum (GIF) Policy Group issues.

The delegates toured the INEEL and ANL-W, and then met in Sun Valley to focus on discussions about what each country will contribute to the research needs of the next generation of nuclear reactors.

The Policy Group is the GIF's governing body, and is responsible for overall framework, policy formation and strategic planning. The group meets two or three times a year in various member countries.

William D. Magwood IV, director of DOE's Office of Nuclear Energy, Science and Technology, is the chair of the group, whose other members include senior government officials from the GIF members. These are the United States, Argentina, Brazil, Canada, France, Japan, Korea, South Africa, Switzerland and the United Kingdom, along with the European Atomic Energy Community (Euratom).

While visiting Idaho high schools earlier this year, Magwood invited several students from Idaho Falls and Boise high schools to attend the GIF Sun Valley meetings, have lunch with the international visitors and share their thoughts on the importance of science in planning for this nation's energy future.

Matt Fields, a student at Boise's Timberline High School, told the international leaders that science has drastically improved the quality of life for everyone and the research "is making my science fiction into reality." He said the conference opened his eyes to some of the research taking place. "This conference makes my horizons boundless."

Idaho Falls High School student Herb Pollard IV emphasized the importance of planning for tomorrow's energy needs. After sitting in on the nuclear energy presentations, he was impressed. "I see your generation is planning for my generation," he said.

Ralph Bennett, INEEL Advanced Nuclear Energy director and technical director of the GIF, said he was pleased the group selected Idaho as a meeting location. "They all know the new Idaho National Laboratory, including both INEEL and ANL-W, will be a centerpiece for nuclear energy research."

Background

In 2000, the DOE's Office of Nuclear Energy, Science and Technology engaged governments, industry and the research community worldwide in a wide-ranging discussion about the development of next-generation nuclear energy systems, known as Generation IV. The result was the formation, by charter in 2001, of the U.S.-led Generation IV International Forum.

A Generation IV Technology Roadmap prepared by GIF member countries identified the six most promising reactor and fuel cycle systems, and the research and development necessary to advance them to commercial deployment. Those six systems are: gas-cooled fast reactor, lead alloy liquid metal-cooled reactor, molten salt reactor, sodium liquid metal-cooled reactor, supercritical water-cooled reactor and very high temperature gas reactor. These systems offer advantages in the areas of economics, safety and reliability, and sustainability. They could be deployed commercially by 2030 or earlier. Three of the six Generation IV systems offer the added benefit of being able to "co-generate" hydrogen.

(For more information, call Teri Ehresman, 208-526-7785)

Students from Idaho Falls and Timberline high schools met with Generation IV International Forum Policy Group members and meeting organizers in early May. The delegates were in Sun Valley to discuss what each country will contribute to the research needs of the next generation of nuclear reactors.

PN04-0104-03-02

Energy Security

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But the INEEL is, at its heart, an applied engineering laboratory and its staff would not be content simply identifying the problems. National Security researchers are coming up with solutions.

Engineers have developed a sensor that attaches to power transmission poles. The sensor can detect tampering, such as someone trying to disconnect a guy wire, and alert a central control center.

All threats are not physical, however, so Laboratory computer engineers have developed sophisticated code to detect cyber intruders, and they are educating the energy industry on this and other intrusion detection systems.

In other programs, staff is concentrating on reducing the vulnerabilities – both physical and cyber – of the automated control systems that run many critical infrastructure assets. Because Laboratory staff has designed, built, operated and still maintains a variety of these process control systems for everything from the INEEL's power distribution to chemical reprocessing and manufacturing activities, the Laboratory is particularly qualified in this arena. The Department of Homeland Security and Department of Energy recognize INEEL's expertise and rely on Laboratory staff to address this international concern.

Some of the best minds in the country are looking at conventional and alternative energy sources. INEEL National Security experts are helping to protect the systems to keep that energy flowing reliably.

(For more information, call Kathy Gatens, 208-526-1058)

Focusing on Nuclear Energy, Hydrogen Research

The Department of Energy's Nuclear Hydrogen Initiative is seeking to develop efficient methods of producing the fuel of the coming "hydrogen economy" without generating greenhouse gas emissions in the process.

Researchers at the INEEL are playing key roles in this national effort.

INEEL researchers Jim O'Brien, Carl Stoots and Paul Lessing are working on a project using high-temperature electrolysis to produce hydrogen. This process combines heat and electricity to separate water into hydrogen and oxygen more efficiently than using electricity alone.

Hydrogen and oxygen can be combined to produce electricity and water in a fuel cell. Operating in reverse, the scientists are applying electricity and high-temperature heat in solid-oxide cells to split water into hydrogen and oxygen.

The efficiency of this simple process improves with increasing temperatures. The source of the higher temperatures will be from the next generation of nuclear reactors. This type of demonstration reactor has been proposed for the INEEL.

"The equipment for this technology is small, simple and modular, making it easy to manufacture," said Steve Herring, INEEL project lead. "The challenges are in combining a large number of modules and in reducing the overall cost of the plant."

The INEEL has developed a small, laboratory-scale high-temperature electrolysis test demonstration facility in Idaho Falls. In collaboration with Ceramatec, Inc., of Salt Lake City, scientists have been successfully testing small-scale "button cells," about one-and-a-half inches in diameter, to demonstrate the hydrogen technology.

Because of the success of the small-scale testing, a larger electrolysis stack test has already been performed. In this scientific study, four-inch square cells have been combined into a six-cell electrolysis stack. They've been operated for over 1,100 hours at the Ceramatec facility, producing 32 liters of hydrogen per hour, a rate equal to the performance of the largest operational thermochemical experiment to date.

These small-scale experiments represent the preliminary steps toward intermediate- and large-scale facilities that will be required to produce hydrogen in the future. The DOE's Nuclear Hydrogen Initiative calls for a demonstration facility for High Temperature Electrolysis by about 2008 and a larger 500-kilowatt pilot plant demonstration facility around 2011.

Several other research teams, led by INEEL's Dan Ginosar, are studying methods for producing hydrogen using heat from a nuclear reactor. These "thermochemical" processes can use compounds of sulfur and iodine, or calcium and bromine, to split water into hydrogen and oxygen.

The INEEL has several projects under way to address technical challenges of some of the more promising thermochemical systems. These include identifying materials that can withstand the high temperatures and corrosive conditions in the operating reactors, developing efficient separation methods for complex chemical mixtures used in thermochemical processes, and developing membranes for use in high-temperature hydrogen separation.

Hydrogen research is important to the INEEL and the nation. "We are working with other DOE national labs on important work that will lead to the eventual demonstration of hydrogen production using nuclear energy. That research can have a huge, positive impact for our nation and the world, both in reducing our dependence on imported oil and in reducing our emissions of greenhouse gases," Herring said.

(For more information, call Teri Ehresman, 208-526-7785)

Jim O'Brien and Carl Stoots perform research as part of a small, laboratory-scale high-temperature electrolysis test demonstration facility in Idaho Falls.

PN04-0055-01-33

Best Attributes

continued from page 1

(The home page for both RFPs is www.id.doe.gov.)

"The technologies that will be born at this lab will help us realize our far-reaching energy and environmental goals of reducing our dependency on foreign sources of energy, while still allowing for vibrant economic growth," said Abraham.

A key element of the INL RFP is for the successful contractor to assume a prominent role in the research, development, design and exploration of Next Generation Nuclear Plant technologies. DOE is exploring the possibilities of building a prototype nuclear reactor to demonstrate this "next generation" technology. Such a facility would bring together the best nuclear expertise from the United States and around the world to demonstrate the use of ultra-safe, proliferation-resistant technology that would produce reliable electricity and large quantities of hydrogen for transportation and industrial uses. Nuclear power is a technology that does not emit "greenhouse gases," so therefore does not create air pollution problems. Hydrogen is also a potential source of clean-burning energy that could eventually replace fossil fuels in automobiles and other machines.

DOE intends to partner with Idaho universities and those from other regional states to develop a joint laboratory/university center for advanced energy studies in Idaho. DOE believes a center of this type would contribute significantly to the establishment of a world-class research facility, and make eastern Idaho an international focus for energy education and research.

The INL will continue to be a leader in science and technology for nuclear nonproliferation and in protecting critical infrastructure systems in the United States. The Idaho laboratory will build on its role in providing support for the licensing and operation of the Yucca Mountain spent nuclear fuel repository under development in Nevada. The INL will provide support to NASA and its deep space missions, manufacturing space batteries and providing research assistance. Finally, the INL will play a leading role in the Advanced Fuel Cycle Initiative to develop a better, more efficient and proliferation-resistant nuclear fuel cycle while reducing the amount and toxicity of nuclear waste that has to be disposed of in a geologic repository.

DOE intends to select the winning contractor for the INL in November of this year, with the successful contractor taking over Feb. 1, 2005.

(For more information, call Brad Bugger, 208-526-0833)

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Detecting Minute Changes

INEEL researchers develop, market breakthrough in digital imagery technology

Digital systems are changing our 21st-century lives by digitizing details of everything from medical images and music to manufacturing and national security.

A team of scientists at the INEEL has developed the Change Detection System, a technology that instantly highlights the slightest differences between digital images. In fact, lead researcher Greg Lancaster convinced doctors of the program's power when he used it to compare scans of his own brain after surgeons removed a tumor. Medical technology firms already are vying to license the program.

Selected as one of the most promising technologies for 2003 by R&D Magazine, CDS has been spotlighted on more than 75 Web sites worldwide and received more than 200 business inquiries about licensing.

A direct result of applying national security technology funded from the DOE's Applied Technology Program, CDS is so quick and easy that a 10-year-old child can operate it. An affordable and relatively small 350 KB program, it can operate on a standard PC or even a handheld computer.

CDS quickly compares side-by-side images to identify any differences. No longer do experts have to use the manual flip-flop reflex comparison method, which can be prone to errors.

Now, the CDS technology developed by the INEEL's Lancaster, James L. Jones and Gordon Lassahn combines the strengths of rote computer analysis with the powerful human reflex elicited by the flip-flop technique. The CDS program aligns images to within a fraction of a pixel, while compensating for differences in camera angle, height, zoom or other distractions.

Flipping between two CDS-aligned images reveals once-imperceptible differences. Tiny retinal changes signal macular degeneration. Small earthen shifts herald hill erosions. Footprints appear in a gravel road. Such versatility makes the program attractive to everyone from security guards to working parents and field researchers to physicians. Potential applications for this technology include surveillance, forensics, national security, home security, field research and medical imagery, all thanks to Lancaster's willingness to apply it to his own medical needs.

You can find more information on CDS, including photo illustrations, by visiting www.inel.gov.

(For more information, call Kathy Gatens, 208-526-1058)

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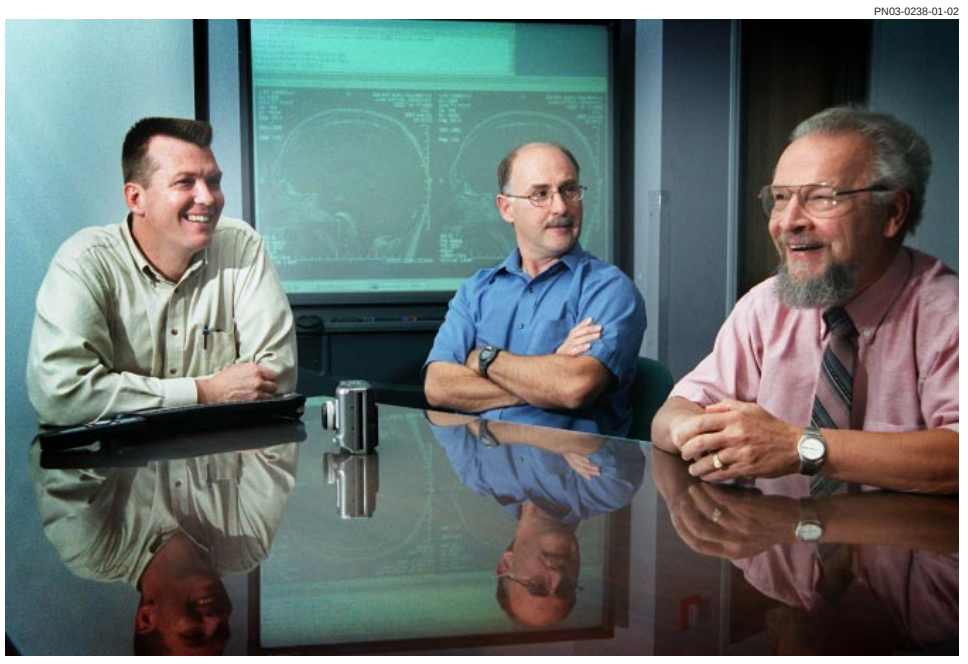

The Change Detection System was developed by (left to right) Greg Lancaster, James Jones and Gordon Lassahn.

Although the two brain scan images (below left) appear identical, the Change Detection System reveals changes that have developed in the time between scans.

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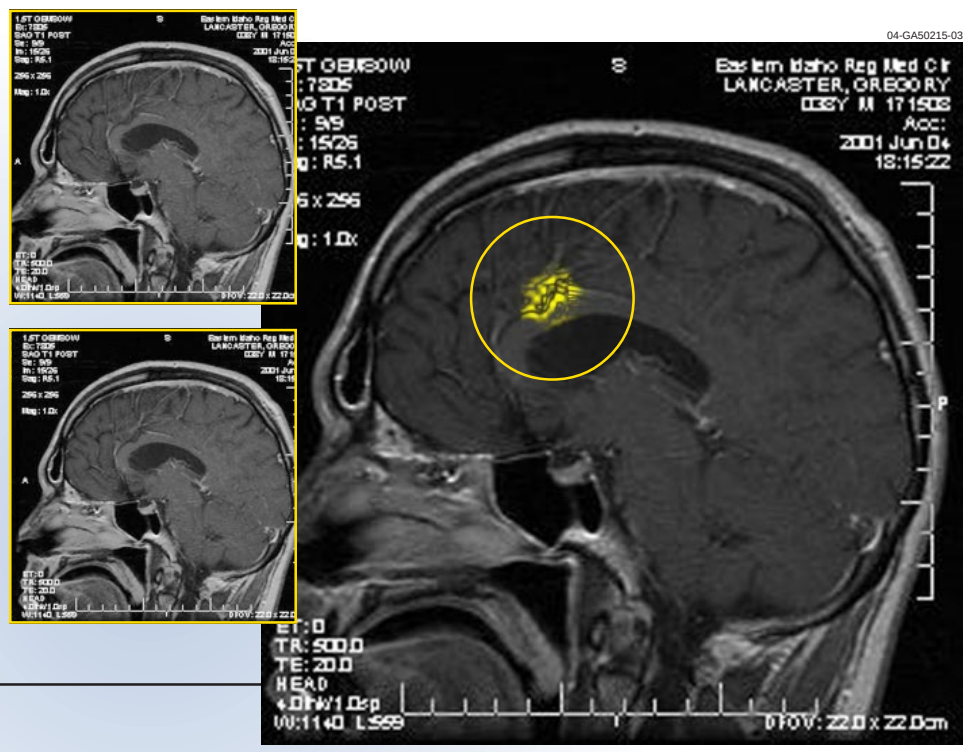


Corporate Resources Enhance Research

Corporate members of Bechtel BWXT Idaho have committed $32 million of their performance fees during the past four years to fund 80 research and development projects at INEEL.

This special effort is called the Corporate Funded Research and Development (CFRD) program. BBWI's corporate parents, Bechtel National Inc. (BNI), BWX Technologies, Inc. (BWXT) and the Inland Northwest Research Alliance (INRA) have selected projects of mutual benefit to the INEEL and to one or more of these partner corporations. These projects enhance key INEEL capabilities necessary to accomplish its Department of Energy missions, help commercialize an INEEL technology, or serve an advanced technical need.

"The CFRD Program delivers key resources to INEEL that ensure the health and welfare of this national laboratory. CFRD combines challenging work with the focus and urgency of a customer dealing in the commercial world. It has been a very successful program," said Rich Rankin, INEEL's CFRD program manager.

The results have been dramatic and offer tremendous promise for the future. For example, the Wireless Test Bed, sponsored by Bechtel, has created an open-air, end-to-end capability for independent testing of next-generation integrated voice and data communications for mobile users. Bechtel Telecommunications and Bechtel National teamed with INEEL to construct and operate the Wireless Test Bed. Now completed, the Test Bed provides integrated testing for wireless carriers, vendors and government agencies, including third- and fourth-generation cellular phone systems.

Linda Trocki, Bechtel National, Inc. principal vice president and manager, Research & Technology, said, "CFRD has been a real win-win. It has provided a substantial amount of funding as well as interesting technical work for the Lab's scientists and engineers, while helping Bechtel solve technical problems for our customers."

The team includes Jake MacLeod and Ken Anderson of Bechtel, who partnered with Jane Gibson, Wayne Austad and Lynda Brighton of INEEL.

Among technologies still in development is the Diesel Reformer Project, sponsored by BWXT. This project is working to design, fabricate and test an integrated diesel fuel reformer to support a 500-kilowatt electric fuel cell power generation system for marine applications. The process design was previously completed by BWXT and established the basis for the INEEL project.

The Diesel Reformer directly supports BWXT's development of diesel reforming technology for application to naval ship fuel cell systems, as well as INEEL's clean fuels initiative. The team includes Bob Ryan, Steve Scoles, Ray Sullivan and Cort Coghill, all from a BWXT affiliate, as well as Bob Carrington, Bob Cherry, David Jenkins, Joe Palmer, Barry O'Brien and John Connor of INEEL.

(For more information, call Keith Arterburn, 208-526-4845)

04-GA50215-04

The Diesel Reformer Project is working to design, fabricate and test an integrated diesel fuel reformer to support a 500 kWe fuel cell power generation system for marine applications.

UAVs Take Flight Over Idaho

Low-cost unmanned aerial vehicles (UAVs) are promising not only for national security missions, but for civilian applications as well.

PN03-0236-08-16

The plane banked and turned over the shimmering desert as the ground crew squinted up intently, silently watching every wing tilt. It landed hard into the wind, skidding across the tarmac before coming to rest quietly just at the edge of the sand and sagebrush. No pilot emerged from the cockpit. Instead, a single crew member approached the plane, picked it up and carried it back to the command center.

This flight was just one of hundreds INEEL's unmanned aerial vehicle team flies during operations of its multiple research and development projects.

Unmanned aerial vehicles, or UAVs in the parlance of the experts, look somewhat like the hobby planes flown by aviation aficionados worldwide. But these UAVs, explained project manager Scott Bauer, have a special purpose.

"It's not the plane, it's what they can do," said Bauer. "We're working with DARPA (Defense Advanced Research Projects Agency) Future Combat Systems Communications program to prove that small, low-cost UAVs can perform combat missions."

The UAVs used by Bauer and his team are not quite off-the-shelf systems. They include sophisticated avionics that unleash the birds from constraining radio frequency controls to roam the skies for hours, on predetermined flight paths. Before the military risks soldiers and battles on the reliability of the relatively tiny planes, Bauer and team members Mark McKay, Matt Anderson and Jodie Boyce launch, fly and land plane after plane.

Mobile, scientific platforms

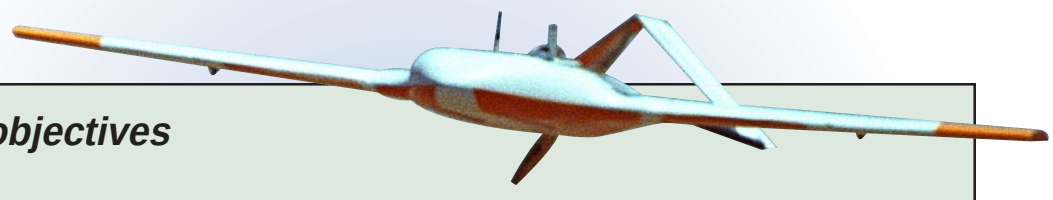
While Jerry Harbour recognizes the importance the military plays in UAV technology development, he also sees enormous potential for myriad peacetime scientific applications. Harbour is the acting manager for the Human, Robotic and Remote Systems organization, home to UAV team members McKay and Anderson and hotbed for much of the INEEL's robotics work.

"So much in science research is gathering of data, and collecting good data has been expensive," said Harbour. "UAVs today are smaller, cheaper and can be loaded with powerful sensors. When you add a long loiter time, you have a mobile scientific platform, perfect for hundreds of scientific applications."

Loiter time is the ability to stay aloft in an area. Some UAVs – even small, inexpensive ones – can circle a site for hours. Studies conducted in remote or dangerous locales – such as when assessing pollutant effects on delicate coral reefs, elephant migrations across the African veldt, or awakening volcanoes on Pacific atolls – are all ideal applications for UAVs.

"You can't do these things with satellites," said Harbour. "They flash by and are gone. Manned aircraft is very expensive and sometimes dangerous. UAVs are perfect."

(For more information, call Kathy Gatens, 208-526-1058)



UAVs take on variety of objectives

In addition to studies for military and basic science applications, INEEL researchers are developing helicopter and fixed-wing unmanned aerial vehicles to monitor for airborne contaminants, such as those caused by wildfires and other unexpected events. The Environmental Services Project and the Human, Robotic and Remote Systems Department worked together to develop the Robotic Air Monitoring System.

The air monitoring team incorporates a real-time automated guidance system on a UAV to collect air samples within airborne plumes to obtain accurate data. INEEL engineers added instruments to ensure that when samples are taken, an onboard global positioning system (GPS) records where and when the samples were taken. In tests at the INEEL, the low-power, lightweight UAVs fly over a 15-mile radius and use a microcomputer to automatically fly the aircraft to a sample collection point and then return to the launch area. UAVs already have been used to perform aerial photography of facilities at the Central Facilities Area and Vadose Zone Research Park, and for routine environmental monitoring near the Test Reactor Area.

Argonne National Laboratory-West Supports Deep Space Exploration

Argonne's Royal Pond works on the Radioisotopic Thermoelectric Generator.

04-GA50215-05

NASA rovers Spirit and Opportunity, which landed on Mars in January, are carrying Department of Energy radioisotope heater units that keep the rovers' onboard electronics warm during the cold Martian nights.

For 40 years, DOE has worked with NASA on heater units like these and on radioisotope thermoelectric generators (RTGs) used to power spacecraft. Argonne National Laboratory-West on the INEEL Site is now part of DOE's support for NASA.

Last year, DOE's ANL-W worked with Los Alamos National Laboratory to supply NASA with the heater units.

Two years ago, DOE decided to move the assembly and testing of the space power systems to Argonne-West to reduce project costs and improve security.

With the move to ANL-W to be completed this July, the lab is making plans to meet NASA's many new missions in the future that will use these systems, including delivery of the next RTG to support NASA's 2006 mission to Pluto.

In space, power is a precious commodity. In Earth's orbit, a five-foot-square solar panel will produce about 300 watts of electricity, about as much as an RTG, and equal to three 100-watt light bulbs. But to produce the same power at Pluto, 7 billion miles from the Sun, a solar panel would have to be about half the size of a football field. Without nuclear technologies, such as RTGs, exploration of deep space would not be possible.

Radioisotope heater units generate heat from decay of plutonium-238 to heat the spacecraft's electronics. RTGs convert the heat generated by radioactive decay of plutonium-238 into electricity.

These systems have been standard equipment on manned and unmanned spaceflight since 1961, from the Apollo lunar landings, the Voyager explorations of Jupiter, Saturn, Uranus and Neptune, to the 1990s explorations by Galileo and Cassini. This July, Cassini, powered by three RTGs, will reach Saturn.

The RTG work at ANL-W is conducted in the complex that houses the Zero Power Physics Reactor.

(For more information, call Betsy Connell, 208-533-7837)

PN03-0336-01-04

Taking Direct Aim at Terrorism

INEEL physicist James Jones has developed a technology with the ability to rapidly and accurately detect shielded weapons-grade materials hidden within cargo containers.

A cutaway of a commercial cargo container sits on the concrete floor of a laboratory. Hidden inside, under thick blocks of wood and layers of polyethylene and lead, is an innocent-looking vial. INEEL National Security Program physicist James L. Jones aims an accelerator beam at the container and in less than two minutes, reveals that the vial contains uranium.

The demonstration was done for an audience of scientific peers and representatives from the Department of Homeland Security and the Defense Threat Reduction Agency. They were on hand to witness the INEEL-developed technology's ability to rapidly and accurately detect shielded weapons-grade material hidden within the container – the same type of cargo containers that daily enter U.S. borders by the thousands.

"Nuclear smuggling is a real threat," said Jones. "I've demonstrated just what this technology could do against it." For several years, the Department of Energy's National Nuclear Security Administration has funded research projects to address nuclear smuggling. Jones and others had been working under the auspices of DOE until program oversight was transferred to the newly formed Department of Homeland Security.

Jones teamed with DOE's Los Alamos National Laboratory and a commercial company to develop the system that could be deployed at the nation's ports of entry. The technology has the added benefit of being adaptable to a variety of commercial inspection platforms.

He uses a transportable electron accelerator to produce energetic photons. These photons interact with the object being examined, or interrogated – in this case, the cargo container. This process, which occurs in less than the blink of an eye, induces fission – divisions in the atomic nucleus – in nuclear material. Other materials do not fission.

Jones has designed a patent-pending detector that can pick up and characterize this fission event. The pulsed photonuclear neutron detector detects the presence of shielded nuclear material and can differentiate between highly enriched uranium, depleted uranium or thorium when a second beam at a different energy level is directed at the object.

"There are thousands of ways to configure a cargo container," said Jones. "We've picked a couple of challenging ones to demonstrate. We are developing standard testing configurations so we can compare our results with other technologies."

An official of Homeland Security attending the demonstration said the Department is planning to identify technologies with the best chance of solving real problems and then testing them methodically.

(For more information, call Kathy Gatens, 208-526-1058)

Revealing Images

Detector pinpoints concealed weapons threats

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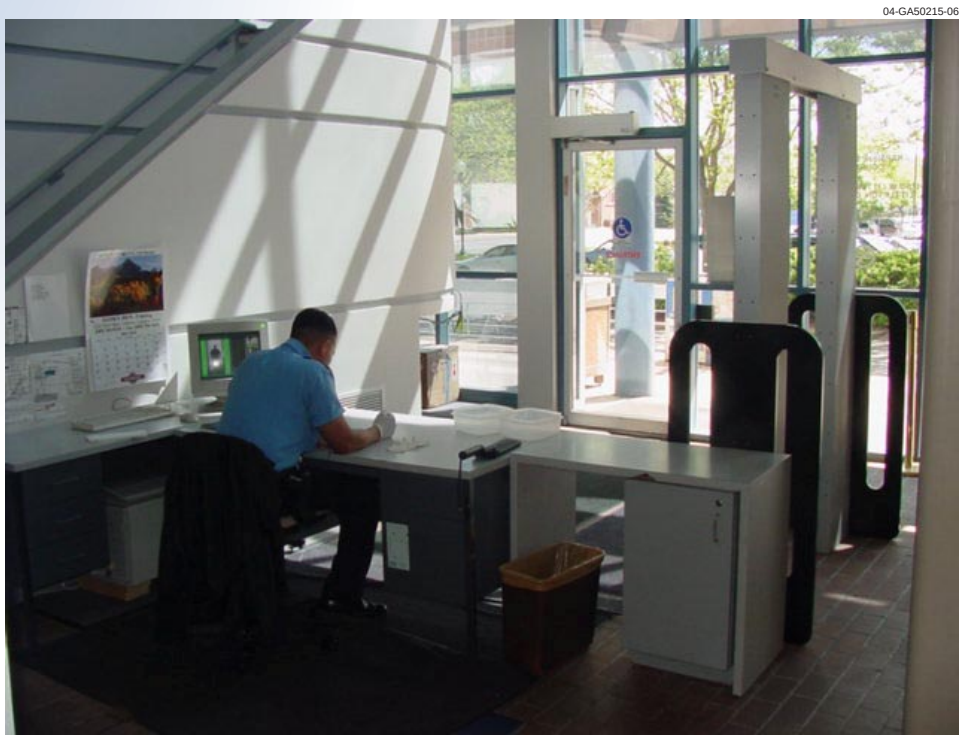

The new INEEL weapons detector is sophisticated enough to discriminate between threat and nonthreat items such as keys and coins. And it is sensitive enough to identify threat items as small as a box cutter or razor blade.

The first INEEL-designed concealed weapons detector was installed at the Bannock County Courthouse in Pocatello in 1998. Over the years, it has stopped scores of weapons from entering the courtrooms, and many from even being brought into the building.

Fast-forward to 2003 at Washington Irving High School in New York City. The next-generation INEEL concealed weapons detector, now commercialized and marketed by View Systems, Inc., detected a student trying to sneak a razor blade in his mouth into school.

The system is a passive device that senses disturbances in the ambient earth's magnetic field – disturbances such as those caused by a weapon passing through the aperture of the portal.

Since the original weapons detector was installed, INEEL researcher and electrical engineer Dale Kotter has designed enhancements to increase system sensitivity, further reduce false alarms and recognize evolving weaponry.

The INEEL detector uses a proprietary method to process and transform thousands of real-time data points from the portal detector array of sensors into a signature pattern for analysis.

Threat items, such as guns and knives, and nonthreat items, such as cell phones and pagers, produce unique magnetic signatures, almost like fingerprints. The signature is variable and can be impacted by some of the same factors as those affecting electromagnetic detectors – typical airport metal detectors – such as a person's gait and how fast people walk through the portal, proximity to the center of the portal and background clutter. The orientation of the weapon can impact the signature.

Kotter uses several signal process methods to analyze the magnetic signature so that the system doesn't miss even the slightest threats. He has worked with the sensor manufacturer, Quantum Mechanics, to improve sensitivity by embedding microprocessors into the sensors.

He continues to test the INEEL system for accuracy reproducibility. He and colleague Lyle Roybal have tested against the "dead zone" – the mid-portal area where many standard detectors are unable to identify missed items – and found that advanced signal analysis techniques could identify items.

They've performed highly successful experiments on items that tend to produce false alarms, such as watches and cell phones. The experiments also produced a high success rate in finding multiple weapons a person is carrying and the locations on the body where they are hidden.

The INEEL is developing a solution that can pinpoint the locations of a hidden knife yet allows to pass the average traveler who is carrying only a cell phone and keys.

(For more information, call Kathy Gatens, 208-526-1058)

Mapping a Renewable Energy Resource

Researchers at the INEEL recently completed the first phase of an innovative assessment of water energy resources in the United States. The study estimated that 170,000 megawatts of this clean, sustainable energy source remains untapped and is not restricted from development by federal policies and regulations. The next phase will determine how much of this power potential can feasibly be developed.

The evaluation ranked Idaho third in the country with water energy resources of 12,000 megawatts, exceeded only by Alaska and Washington. More than half of the available potential is in Alaska and the Pacific Northwest.

This study was the first step of a low-power hydropower project funded by the U.S. Department of Energy. The study assembles in one place – and in a manner never before achieved – comprehensive engineering estimates and details about the abundance of U.S. water energy resources.

Industry has developed less than 20 percent of water energy resources in the country. Almost 60 percent of the nation's water energy resources are potentially available for development. The rest of the resources are located in federal exclusion zones, such as wilderness areas and on wild and scenic rivers.

"The study gave us an estimate of the natural resource that is four times the average annual power of all the existing hydroelectric plants in the country combined," said Doug Hall, INEEL project manager. "It also showed the locations and concentrations of resource sites everywhere in the country. We are excited to see how much of the potential can actually add to the nation's energy supply."

State-of-the-art digital elevation models and geographic information system tools were used to model and assess the power potential of all the stream segments averaging two miles in length in each of the country's 20 hydrologic regions. The power potential of stream segments within federal exclusion zones and power from existing hydroelectric plants were subtracted to determine "available" power potential.

Like windmills above ground, "watermills" under water and other new hydropower technologies not requiring a dam should be useable at a large number of the potential sites.

The development of the available resources is primarily dependent on stream flow continuity, site accessibility, and proximity to markets and existing power infrastructure. Applications such as generating electricity, hydrogen production and water purification in the United States and in developing countries make low-power hydropower a subject of interest to the DOE and continuing research and development by the INEEL.

Detailed information about nationwide water energy resources by hydrologic regions and all 50 states is reported in *Water Energy Resources of the United States with Emphasis on Low Head/ Low Power Resources*, April 2004. To access this report and more information about the DOE's Hydropower Program, visit http://www.eere.energy.gov/.

(For more information, call Reuel Smith, 208-526-3733)

More than half of the available U.S. hydropower potential is in Alaska and the Pacific Northwest. Idaho has a potential of 12,000 megawatts.

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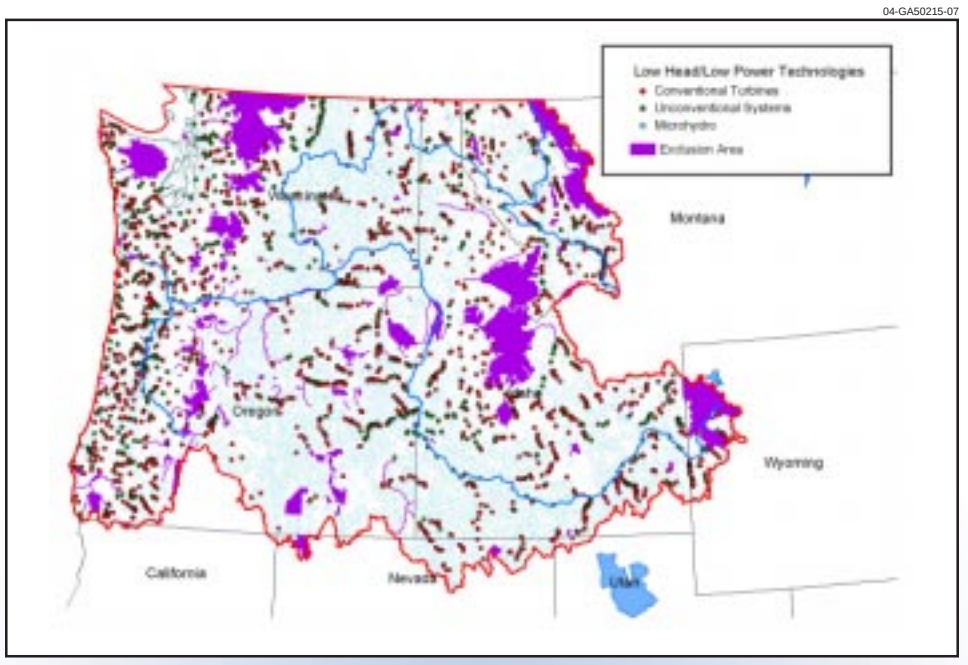

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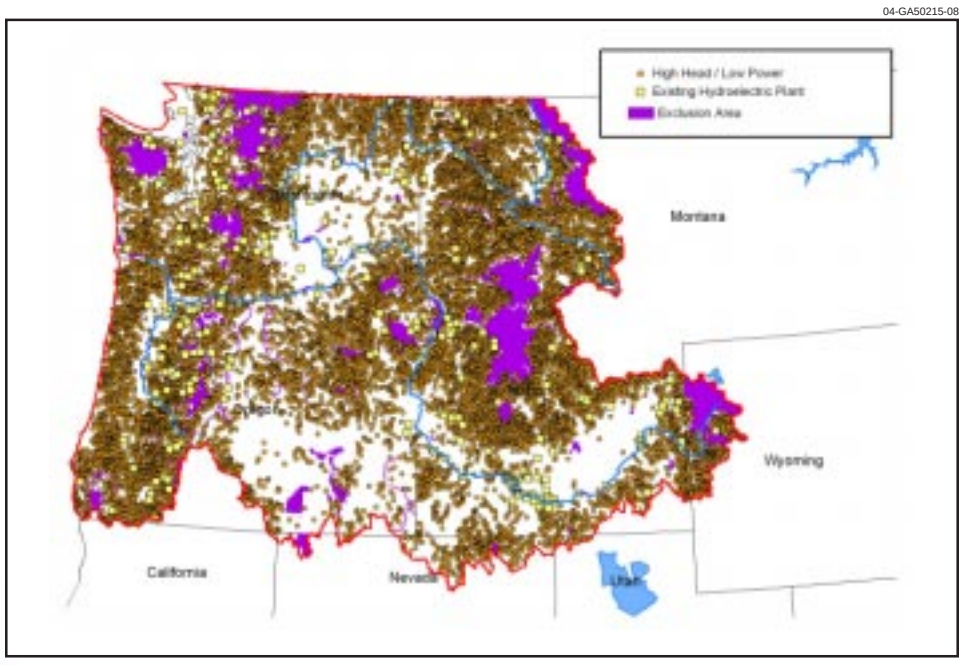


PN93-0408-01-24

Uncovering Answers

INEEL, Lawrence Berkeley sign agreement to study critical issues of the earth's subsurface

Two Department of Energy national laboratories are combining expertise to answer a variety of critical issues involving the earth's subsurface.

The Idaho National Engineering and Environmental Laboratory and Lawrence Berkeley National Laboratory will be seeking congressional funding of more than $400 million to create the Consortium for Research on the Earth's Subsurface (CORES). The two labs, along with a nationally recognized advisory committee, will conduct research to protect aquifers, promote hazardous materials containment, increase agricultural productivity and enhance energy and mineral resource use.

Russ Hertzog, INEEL Subsurface Science Initiative director, said, "LBNL is a leader in the study of earth sciences. We have partnered to promote increased funding to address some of DOE's most significant issues that pertain to problems that exist below the earth's surface."

A research agenda is being developed to provide a program that will complement and leverage established programs while attempting to fill critical knowledge gaps.

In support of the CORES program, the two laboratories completed a number of workshops in 2003, and more are scheduled this year. The workshops allow some of the brightest scientists and engineers from national labs, academia and the private sector to work on subsurface problems. As a goal, the workshops will lead to proposals for an integrated research program in subsurface science to be submitted to DOE and the National Science Foundation to secure further funding. "The payoff for the CORES project is huge," Hertzog said. "It has far-reaching effects in our efforts to provide a healthy environment for our society and to protect ground nationally and internationally."

(For more information, call Steve Zollinger, 208-526-9590)

CORES research will examine how fluids move in fractured rock by studying core samples from the subsurface.

INEEL Designs Yucca Mountain Remote Waste Handling System

The INEEL is designing a prototype remote-controlled system that will permanently close the waste packages of spent nuclear fuel before they are disposed of in the proposed federal repository being studied at Yucca Mountain in Nevada.

Federal law designated Yucca Mountain as the site to be studied for licensing as the national repository for commercial and government spent nuclear fuel and high-level waste. If the repository is licensed, INEEL's Waste Package Closure System would be a key element of the facility's operation.

The INEEL-designed closure system will be used to demonstrate the operations and equipment, and as an operator training facility. The prototype will be constructed and operated at the INEEL.

Philip Wheatley, Yucca Mountain relationship manager at the INEEL, said the project takes advantage of the Lab's established expertise.

"The INEEL has been designated as the DOE lead lab for Nuclear Energy Technology," Wheatley said. "We have a proven history of spent fuel canister welding process development. This expertise will help the Yucca Mountain Project and help meet the nation's need for the safe storage of nuclear waste."

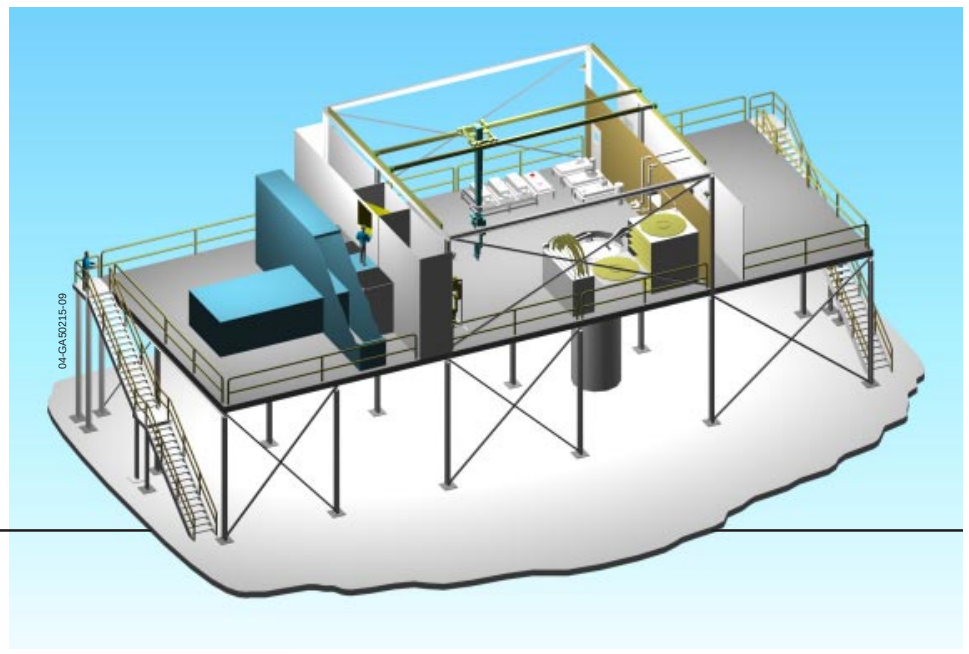
He added that other areas of expertise – in particular, robotics, hot cell operations and design, systems engineering and automated welding developed by the Laboratory in receiving, handling, storing and transporting spent nuclear fuel – made the INEEL attractive to the Yucca Mountain Project team.

In developing the waste package system, INEEL engineers faced a number of technical challenges. The waste package is two containers, one nested within the other, with three lids. The package can be various diameters and heights. INEEL engineers are integrating off-the-shelf equipment in the design of the closure system. The team has had to develop new or modified equipment for some parts of the operation, for instance, a tool to remotely purge and fill the inner container with helium to prevent corrosion.

The task becomes more challenging and complex because the high radiation fields require the entire operation to be done remotely.

"The waste package closure project will be a significant piece of work for the next three or four years," Wheatley said. "This work allows the INEEL to apply some of our core competencies to help meet the nation's nuclear technology development mission. Engineering and other capabilities used for Yucca Mountain will contribute to future reactor development work."

(For more information, call John Walsh, 208-526-8646)



Artist's rendition of the waste container closure platform

Yellowstone Bison Research

Molecular biologists develop sensitive method to detect brucellosis microbe


PN00-0225-01-29

Almost every year, controversy swirls around the issue of bison leaving Yellowstone National Park and possibly infecting cattle with the brucellosis bacteria. There is no quick, accurate way to determine if the bison carry the disease, so the result is that some years, several hundred bison are rounded up and killed.

Two INEEL molecular biologists, Frank Roberto and Deborah Newby, are developing a quick, sensitive and accurate method to detect the brucellosis microbe. Brucellosis is an infectious bacterial disease caused by the *Brucella* species. In animals such as cattle, bison, elk, sheep and goats, the disease can cause spontaneous abortion.

Roberto and Newby are validating a DNA-based field assay they designed using a portable, real-time polymerase chain reaction (PCR) system. Working with the Yellowstone National Park bison biologist, they have obtained blood and tissue samples from about 300 bison captured outside the park this past winter.

They've also worked with the Idaho Fish and Game Department this year to obtain blood and tissue samples from a small captive herd of elk. The idea is to see if the elk are a source of brucellosis.

Newby says that so far, they have found the PCR tests closely match the results of the definitive diagnostic test for brucellosis, cultivation of *Brucella* from samples in a laboratory, which can take several days to weeks. The current field test detects antibodies against *Brucella*, which indicates exposure, but not necessarily current infection. The PCR test provides results in less than two hours in the field, and the equipment fits into a backpack.

Besides being able to detect the bacteria in animals, Roberto and Newby are looking at what samples should be taken from the animals, for instance, blood or reproductive tract tissues.

Also, they are interested in determining how long the brucellosis bacteria last in the environment, so they are collecting soil and fecal samples from rangeland to test. If the bacteria die after a period of time in the soil following birth or abortion events, there may be no risk from both bison and cattle sharing land at different times.

The PCR testing was the outgrowth of the National Park Service contacting the INEEL's biotechnology organization for help on the brucellosis detection issue. But, says Roberto, the INEEL has a growing national security mission. The PCR testing can be adapted for detecting other organisms and could be used to help combat bioterrorism.

(For more information, call John Walsh, 208-526-8646)

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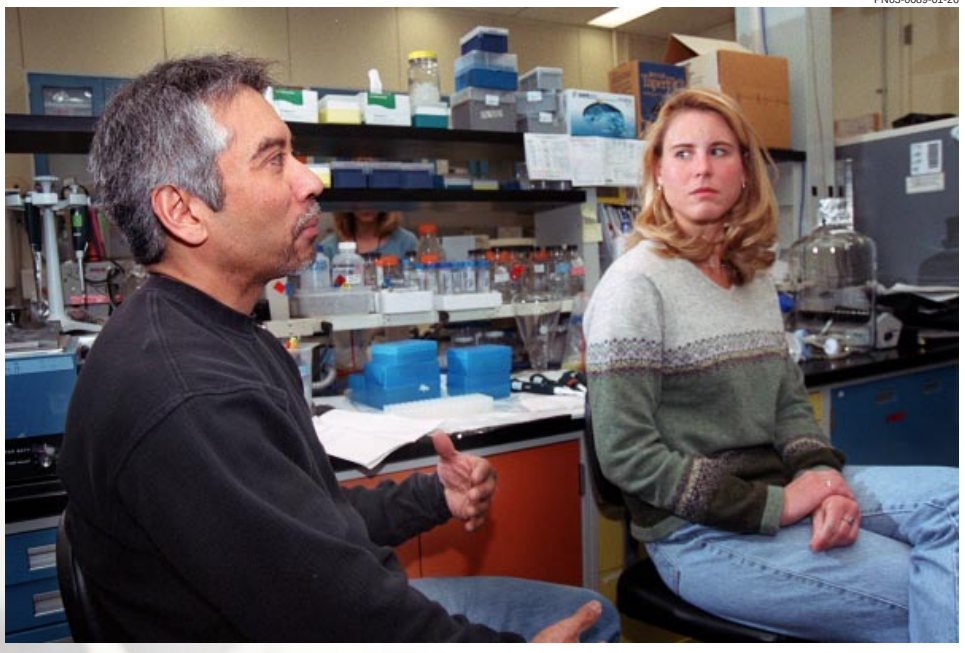


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INEEL molecular biologists Frank Roberto and Deborah Newby are developing a quick, safe, accurate method to detect the brucellosis strain, B. abortus, in the field (above).

Pipules are loaded into a polymerase chain reaction system (left).